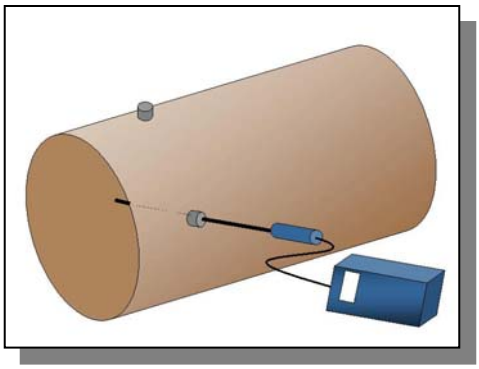
Contents



1.0 Purpose/Scope

This procedure provides a standardized method for conducting a duct traverse to measure the velocity in a local exhaust ventilation (LEV) system. This procedure is used as part of the initial or periodic LEV system effectiveness test described in IH 62400 or IH62410.

The duct traverse method offers a superior measurement over a single "center-line" measurement because it takes multiple measurements in equal areas across the surface area of a round or rectangular duct. This accounts for differences in airflow and density at various locations within the air pathway. These variations in flow result within a duct from the compression of the moving air. System components such as elbows, expansion, contractions, rough walls, protrusions, fans, and filters can cause the airflow at any given point in a duct to not be uniform.

This procedure can be used to measure flow rates based on multiplying the average velocity measurements by the cross surface area of the duct.

2.0 Responsibilities

This procedure will be implemented through the SHSD Industrial Hygiene Group Leader, the RCD Facility Support Group Leader, or other line management of the person conducting the measurement.

3.0 Definitions

Area (A) - surface area of hood opening or duct, measured as:
round duct: $A = 3.14 \times (\text{radius})^2$
rectangular duct: $A = \text{length} \times \text{width}$
Units: English- square feet (ft^2), Metric- Square meters (m^2).

Flow (Q) - volume of air passing a point in space, calculated as:
$Q = V \times A$ (velocity x surface area)
Units: English- cubic feet per minute (cfm), Metric- cubic meters per second (m^3/s)

Velocity (V) - speed of air passing a point in space.
Units: English- feet per minute (fpm), Metric- meters per sec (m/s)

Duct velocity- speed of air in the duct. It must be high enough to prevent particulates from settling out and clogging the duct system.

4.0 Prerequisites

4.1 Prior to testing a local exhaust system, verify the calibration and operability of the test equipment.
4.2 Observe area postings and obtain approval to enter the test area, as required.
4.3 Where practical, shut down the source generating the hazard for worker and testing equipment protection.

5.0 Precautions

5.1 **Hazard Determination:**
5.1.1 This test may be done in areas where chemicals or radiological contamination is

known or suspected to be present. These contaminants can have significant health effects and must receive a hazard evaluation by a cognizant ESH professional.

5.1.2 Air testing meters used in this procedure do not generate Hazardous Waste. The testing equipment will not generate a hazardous environmental emission. The test equipment design does not cause significant ergonomic concerns in routine use.

5.2 **Personal Protective Equipment**

5.2.1 Eye: Safety Glasses with side shields are required.

5.2.2 Hand: Contact with work surfaces should be minimized as it could pose a health risk. Use of this operation in areas of known or suspected chemical or radiological contamination requires the use of disposable gloves. Exam-style, splash gloves are acceptable. Acceptable elastomers are: Nitrile, PVC, and Natural Rubber.

5.2.3 Body:

- If contact of the body with contaminated surfaces is anticipated, a disposable suit should be used. Acceptable Chemical Protective Clothing (CPC) materials include: Tyvek®, KleenGuard®, and cotton. Disposable garments must be discarded as per Hazardous Waste Management Division instruction.

- If contact with potentially contaminated surfaces is not expected, protective clothing is optional. However, if personal clothing items become contaminated, they must be surrendered for BNL cleaning or disposal.

5.2.4 Foot:

- If contact of the feet is anticipated with contaminated surface, disposable shoe coverings, boots or booties should be used. Acceptable CPC material include: Tyvek®, KleenGuard®, and rubber.
- If contact with potentially contaminated surfaces is not expected, shoe coverings are optional. However, if personal shoes become contaminated, they must be surrendered for BNL cleaning or disposal.

5.2.5 Respiratory: Under normal use, respiratory protection is not required. If chemical or radiological levels from contamination in the area cause the OSHA, ACGIH, or DOE standards to be exceeded, respirators are required.

6.0 Procedure

6.1 Measuring Equipment:

6.1.1 Air velocity meter such as the Alnor® swinging vane anemometer or the TSI® thermal anemometer VelociCalc®. Follow the appropriate SHSD IH SOP on the operation of the meter.

6.1.2 Measuring ruler.

6.2 Pre-Testing Inspection of LEV equipment

6.2.1 Verify that the exhaust ventilation system is operating.

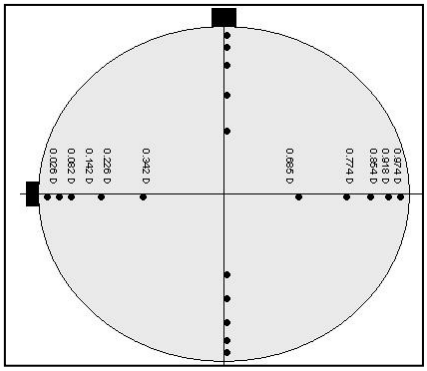
6.2.2 Inspect the exhaust system and its associated ductwork and mechanical components for any obvious signs of damage (e.g., missing or damaged seals, breached ductwork, excessive rust, or unusually loud motor noise). Notify Plant Engineering and the system owner of these conditions. Do not test if the system is not operable or not of adequate integrity.

6.3 Evaluate and document the conditions surrounding the LEV system. Observe and record conditions in the work area, such as:

- Status of doors and windows: open or shut,
- Status of room HVAC system,
- Traffic and movement of people and equipment around the system, and
- Permanent or temporary storage of equipment around the system.

6.4 Locate the sampling ports.

6.4.1 Find the holes in the duct that are used for insertion of the test probe. They may have flanges, fitting, tape, or other sealing mechanism that will be removed.



6.4.2 If no sampling ports are found, consult with an IH professional for placement of ports. Then contact Plant Engineering to install the ports. Wherever possible, the ports should be located at least 8 duct diameters downstream and 2 duct diameters upstream from any major air disturbance such as an elbow, fans, filters, branch entry, etc.

6.4.3 For round ducts, at least two sample ports are needed at 12 and 3 or 9 o'clock.

6.4.4 For rectangular and square duct, sufficient sampling ports must be installed

to allow sampling a grid of at least 16 samples points evenly spaced across the surface of the duct.

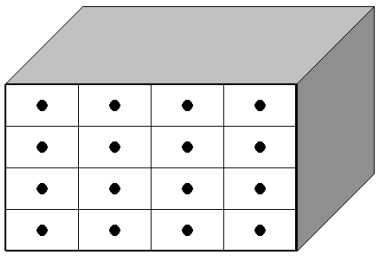
6.5 Measure the duct inner diameter of round ducts or the length and width of rectangular duct. Acceptable measuring techniques are:

- Round: Take measurements of the outer dimensions (minus any insulation thickness and duct wall thickness) and calculating the diameter via:
  D = circumference / 3.14),
- Rectangular: Take measurements of the outer dimensions (minus any insulation thickness and duct wall thickness),
- Insert a measuring device into the duct and measuring the inner dimension.
- Corrugated duct: Insert a measuring device into the duct and measuring the inner dimension at the largest point.

6.6 Mark the probe of the testing apparatus with unit measurements such as inches or centimeters so that the depth of insertion into the duct can be readily detected during the traverse.
Note: Some meters come with the mark pre-etched into the probes. Make sure a collapsible probe is fully extended so the marks are correctly spaced.

6.7 Insert the probe of the testing apparatus into the duct and take readings into the equal area sections as indicated in *Attachment 9.1: Reference on Round Ducts* or Attachment 9.2 *Reference on Rectangular Ducts*. The number of sample points in each traverse is determined by the size of the duct.

- For round ducts 6 inches and smaller: 6 traverse points per axis.
- For round ducts larger than 6 inches: 10 traverse points per axis.
- For very large round ducts and discharge stacks with wide variation in velocity: 20 traverse points per axis.
- For square or rectangular ducts: divide the cross section into equal rectangular areas. Minimum number should be 16 and the greatest distance between points should be 6 inches. Take reading at center of each rectangular area.



6.8 Record the test results on a *LEV Round Duct Traverse* form (Attachment 9.3), *LEV Rectangular Duct Traverse* form (Attachment 9.4), or equivalent.

6.9 Transfer the average measured velocity values to the *LEV System Initial Evaluation Test Record* or *LEV System Periodic Validation Test Record,* if applicable.

6.10 Record-keeping: Provide a copy of the *LEV Round Duct Traverse* form to the ESH Coordinator, the Process/Operation and Exhaust system owner/management, and any other interested parties. The original test report is retained by the organization responsible for the testing in accordance with the BNL record keeping requirements. Send a copy of the record to the SHSD IH lab.

7.0 Implementation and Training

7.1 Tests shall be performed by persons who have demonstrated the competence to satisfactorily perform the tests as evidenced by experience and training.

7.1.1 SHSD: Determination of qualification to use this procedure, testing of applicants, and documentation of qualification shall be set by the IH Group Leader, or designee.

7.1.2 RCD: Determination of qualification to use this procedure, testing of applicants, and documentation of qualification shall be set by the RCD Facility Support Group Leader, or designee.

8.0 References

8.1 American Conference of Governmental Industrial Hygienists (ACGIH). *Guidelines for Testing Ventilation Systems*; 1991.

9.0 Attachments

9.1 *Reference on Round Ducts*
9.2 *Reference on Rectangular Ducts*
9.3 *BNL Exhaust Ventilation* ***Round Duct Traverse*** form
9.4 *BNL Exhaust Ventilation* ***Rectangular Duct Traverse*** form

BROOKHAVEN NATIONAL LABORATORY Safety & Health Services Division INDUSTRIAL HYGIENE GROUP Standard Operating Procedure: Field Procedure	NUMBER IH62470
	REVISION FINAL rev 0
SUBJECT: Local Exhaust Ventilation Duct Velocity Traverse Measurements	DATE 01/06/03
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10.0 Documentation

Document Review Tracking Sheet		
PREPARED BY: **R. Selvey** IH Group Leader **Date 11/20/02**	**REVIEWED BY:** **C. Weilandics** **RCD Facility Support** **Date 01/03/03** **J. Peters** **IH Group Field Service Leader** **Date: 01/03/02**	**APPROVED BY:** **R. Selvey** **IH Group Leader** **Date 01/06/03**
Filing Code: **IH62QR.02**	**DQAR** **Date**	**Effective Date:** **01/06/03**

Periodic Review Record		
Date of Review	Reviewer Signature and Date	Comments Attached

Attachment 9.1
Reference on Round Ducts

Equal Surface Areas For Ducts larger than 6 inches in diameter

10 Traverse Points for LARGE circular duct — Distance of insertion of probe into duct (inches)

Dia (inch)	1	2	3	4	5	6	7	8	9	10
	.026d	.082d	.146d	.226d	.342d	.658d	.774d	.854d	.918d	.974d
> 6	1/8	½	7/8	1 3/8	2	4	4 ¾	5 1/8	5 ½	5 7/8
8	¼	5/8	1 1/8	1 ¾	2 ¾	5 ¼	6 ¼	6 7/8	7 3/8	7 ¾
10	¼	7/8	1 ½	2 ¼	3 3/8	6 5/8	7 ¾	8 ½	9 1/8	9 ¾
12	3/8	1	1 ¾	2 ¾	4 1/8	7 7/8	9 ¼	10 ¼	11	11 5/8
24	5/8	2	3 ½	5 ½	8 ¼	15 ¾	18 ½	20 ½	22	23 3/8
36	1	3	5 ¼	8 1/8	12 3/8	23 3/8	27 7/8	30 ¾	33	35

Equal Surface Areas For Ducts 6 inches and smaller in diameter

6 point Traverse Points for SMALL circular duct — Distance of insertion of probe into duct (inches)

Diameter (inch)	1	2	3	4	5	6
	.043d	.146d	.296d	.704d	.854d	.957d
3	1/8	½	3/8	2 1/8	2 ½	2 7/8
4	1/8	3/8	1 1/8	2 7/8	3 3/8	3 7/8
5	¼	¾	1 ½	3 ½	4 ¼	4 ¾
6	¼	7/8	1 ¾	4 ¼	5 1/8	5 ¾

Conversion from diameter to surface area of duct

Dia. (inch)	1	2	3	4	5	6	7	8	9	10	12	16	20	24	30	36
Area (ft^2)	.005	.022	.049	.87	.136	.196	.267	.349	.442	.545	.785	1.396	2.182	3.142	4.91	7.07

BROOKHAVEN NATIONAL LABORATORY Safety & Health Services Division INDUSTRIAL HYGIENE GROUP Standard Operating Procedure: Field Procedure	NUMBER **IH62470** REVISION **FINAL rev 0**
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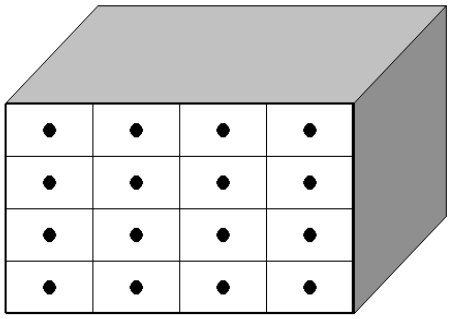
Attachment 9.2

Reference on Rectangular Ducts



(Distance between centers <u>not</u> <u>more</u> than 6 inches.)

Airflow and velocity in the cross section area of a duct may not be uniform. Velocity is typically less at the edges and at a maximum in the center of the duct.

Measurement of the velocity at only one point in the duct or face will not yield a true value for the average within the duct. For the highest accuracy, it is necessary to average the velocity measured at points of EQUAL AREA within the duct. The figure to the left gives an example of where the sampling points should be taken across the face of the hood or duct. These points are the center of equal areas in the duct.

The maximum distance between the centers should not be more than 6 inches. The total number of sample points is determined by the area of the duct.

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EXHAUST VENTILATION SURVEY FORM

ROUND DUCT VELOCITY TRAVERSE

DATE:	SURVEYOR(S):

Error! Bookmark not defined.I. AREA INFORMATION		
DEPT:	BLDG:	ROOM:
EXHAUST SYSTEM I.D.:		
EQUIPMENT EXHAUSTED:		
CONTAMINANT(S):		

II. SURVEY INSTRUMENT INFORMATION	
INSTRUMENT:	CALIBRATION DATE:
MODEL:	SERIAL #:

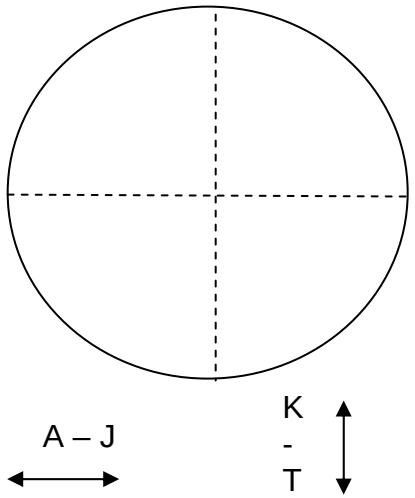
III. RESULTS		
REQUIRED VELOCITY:		AVERAGE VELOCITY:
DUCT DIAMETER:	DUCT RADIUS:	DUCT AREA:
FLOW FORMULA (Q): Q = V x A	FLOW:	TEMPERATURE OF AIR:

Note Location of A - T TRAVERSE POINTS in inches from duct wall

	DISTANCE INSERTION	FPM	M/S
A			
B			
C			
D			
E			
F			
G			
H			
I			
J			

	DISTANCE INSERTION	FPM	M/S
K			
L			
M			
N			
O			
P			
Q			
R			
S			
T			

SKETCH OF TRAVERSE POINTS



Traverse points	Duct Diameter (inch)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
10	.026d	.082d	.146d	.226d	.342d	.658d	.774d	.854d	.918d	.974d
6	.043d	.146d	.296d	.704d	.854d	.957d	---	---	---	---

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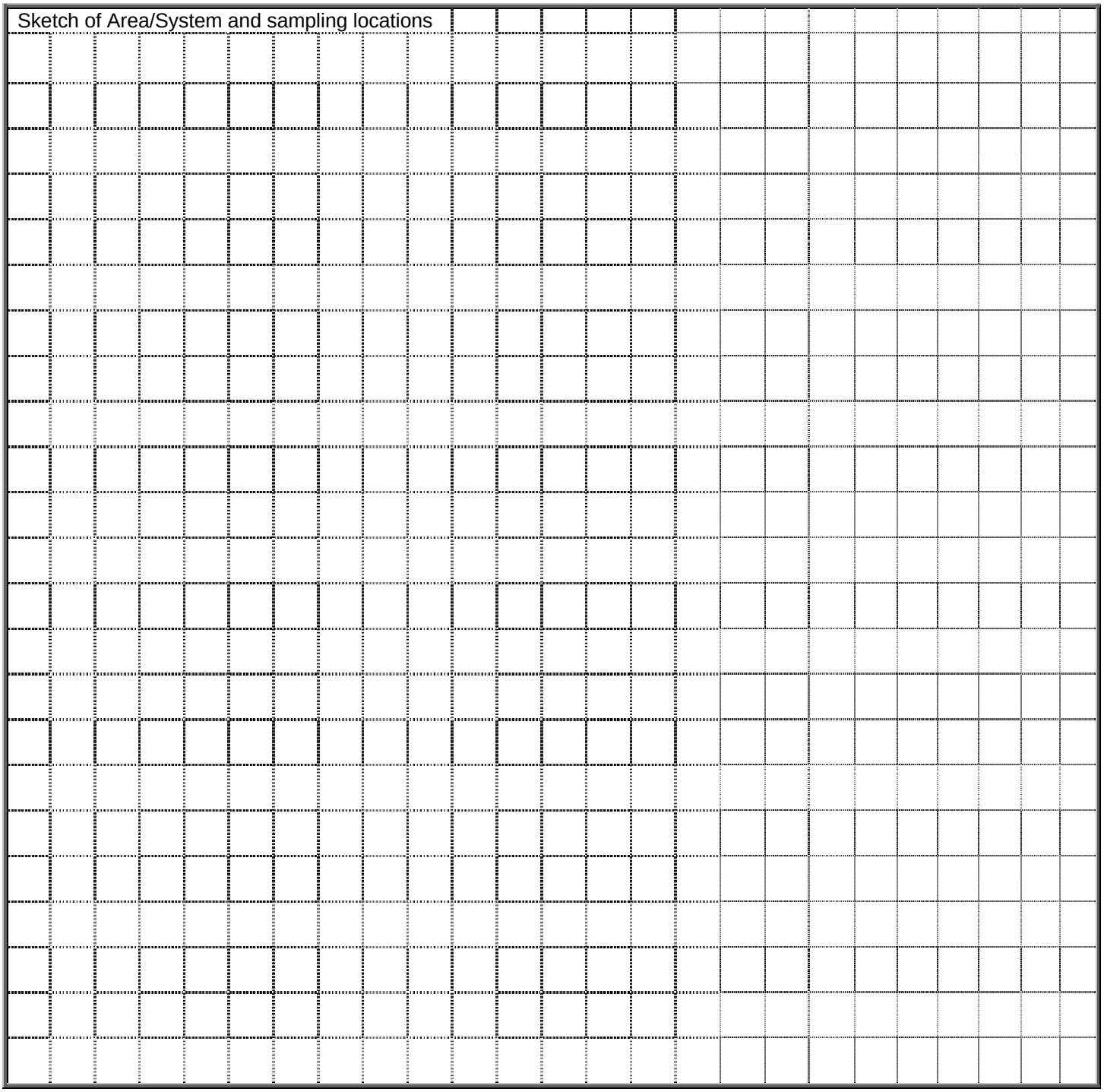
EXHAUST VENTILATION SURVEY FORM

ROUND DUCT VELOCITY TRAVERSE

Sketch of Area/System and sampling locations



Reference

Conversion from diameter of round duct to surface area of round duct																
Dia. (inch)	1	2	3	4	5	6	7	8	9	10	12	16	20	24	30	36
Area (ft^2)	.005	.022	.049	.87	.136	.196	.267	.349	.442	.545	.785	1.396	2.182	3.142	4.91	7.07

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EXHAUST VENTILATION SURVEY FORM

RECTANGULAR DUCT TRAVERSE

DATE:	SURVEYOR(S):

I. AREA INFORMATION		
DEPT:	BLDG:	ROOM:
EXHAUST SYSTEM I.D.:		
EQUIPMENT EXHAUSTED:		
CONTAMINANT(S):		

II. SURVEY INSTRUMENT INFORMATION	
INSTRUMENT:	CALIBRATION DATE:
MODEL:	SERIAL#:

III. RESULTS		
REQUIRED VELOCITY:	AVERAGE VELOCITY:	
HEIGHT:	WIDTH:	SURFACE AREA:
FLOW FORMULA: **Q = V x A**	FLOW:	TEMPERATURE OF AIR STREAM:

SITE FPM

A (1) _____
B (2) _____
C (3) _____
D (4) _____
E (5) _____
F (6) _____
G (7) _____
H (8) _____
I (9) _____
J (10) _____
K (11) _____
L (12) _____
M (13) _____
N (14) _____
O (15) _____
P (16) _____

Sample Locations (no closer than 6 inches each direction to other points)

A	B	C	D
E	F	G	H
I	J	K	L
M	N	O	P

Sketch of System and Sample Location